Large-scale Nanostructure Investigations: Six-dimensional SAXS-CT

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Scanning small angle X-ray scattering (SAXS) combines the reciprocal space resolution of SAXS with real space resolution. A two-dimensional map of the projected two-dimensional reciprocal space information of the sample is recorded by scanning a sample through a focused X-ray beam and recording a SAXS pattern at each point. Nano-structural changes can be investigated over a large distance.

The extension of this combined two-dimensional real and reciprocal space imaging modality to the respective third dimensions has been the purpose of this work. We present six-dimensional small-angle X-ray scattering computed tomography (SAXS-CT) as a method able to investigate the nanostructure in three-dimensional objects several orders of magnitude larger. The combination of SAXS with computed tomography allows to reconstruct the three-dimensional scattering distribution in each voxel of the investigated object [1].
A piece of human tooth served as a sample to demonstrate the method. Dentin in teeth is bone-like, composed of mineralized collagen fibers with variable, albeit well-defined orientations, which give rise to strong SAXS signals. Until recently, it has not been possible to investigate structural changes in this nanocomposite in three dimensions.

We present results of this first full SAXS-CT reconstruction and the voxel-wise extracted collagen fiber orientations and relative scattering strength for a 4mm sized human tooth sample.

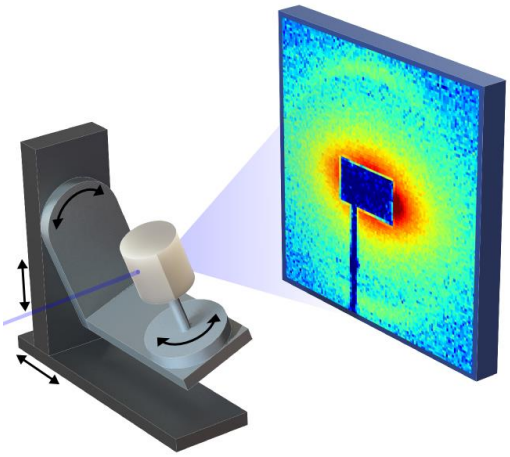

Figure 1: Schematic representation of the Six-dimensional SAXS-CT experiment.

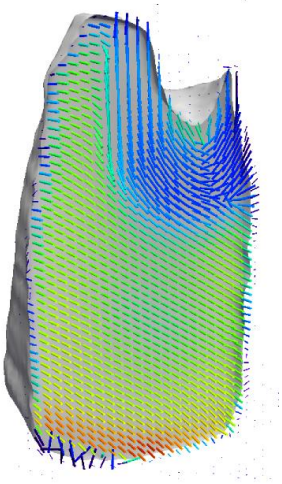

Figure 2: Visualization of the reconstructed collagen fiber orientation inside the tooth.

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References

[1] F. Schaff[1], M. Bech[2], P. Zaslansky[3] C. Jud[1], M. Liebi[4], M. Guizar-Sicairos[4], F. Pfeiffer[1,5], Nature **527**, 353-356 (2015)